

WHAT IS CLAIMED IS:

1. A method for needleless injection of a liquid substance in the skin or
5 other target tissue of a patient, comprising:
 producing droplets of the liquid substance; and
 directing the droplets of liquid substance toward the surface of the
patient's skin or other target tissue at a velocity sufficiently high to inject the
droplets of liquid substance in the patient's skin or other target tissue.
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2. A method for needleless injection of a liquid substance in the skin or
other target tissue of a patient, comprising:
 producing droplets of the liquid substance; and
 accelerating the droplets of liquid substance toward the surface of the
15 patient's skin or other target tissue in order to inject the accelerated droplets of
liquid substance in the patient's skin or other target tissue.
3. A method for needleless injection of a liquid substance in the skin or
other target tissue of a patient, comprising:
20 producing a high velocity jet of gas;
 producing droplets of the liquid substance and supplying the droplets
of liquid substance in the high velocity jet of gas;
 conveying the droplets of liquid substance within the high velocity jet of
gas; and
25 guiding the high velocity jet of gas toward the surface of the patient's
skin or other target tissue in order to inject the conveyed droplets of liquid
substance in the patient's skin or other target tissue.
4. A method as defined in claim 3, wherein producing a high velocity jet
30 of gas comprises:
 supplying pressurized gas from a gas reservoir to a convergent-

divergent.

5. A method as defined in claim 3, wherein producing a high velocity jet of gas comprises:

5 supplying pressurized gas from a gas reservoir to a convergent.

6. A method as defined in claim 3, wherein the high velocity jet comprises inert gas.

10 7. A method as defined in claim 3, wherein producing droplets of the liquid substance and supplying the droplets of liquid substance in the high velocity jet of gas comprise:

introducing liquid substance in a liquid reservoir;

15 pressurizing the liquid reservoir to force liquid substance from the liquid reservoir through a perforated membrane to thereby produce a jet of liquid substance which is transformed into the droplets of liquid substance; and

supplying the droplets of liquid substance in the high velocity jet of gas.

8. A method as defined in claim 7, wherein pressurizing the liquid
20 reservoir comprises:

supplying pressurized gas from a gas reservoir to the liquid reservoir.

9. A method as defined in claim 7, wherein guiding the high velocity jet of gas comprises:

25 guiding the flow of the high velocity jet of gas along a face of the perforated membrane on a side of the perforated membrane opposite to the liquid reservoir whereby the liquid substance forced through the perforated membrane and the resulting jet and droplets of liquid substance are supplied directly within the high velocity jet of gas.

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10. A method as defined in claim 3, comprising producing the high

velocity jet of gas prior to producing the droplets of liquid substance to thereby supply the droplets of liquid substance in a steady-state high velocity jet of gas.

11. A device for needleless injection of a liquid substance in the skin or
5 other target tissue of a patient, comprising:

means for generating droplets of the liquid substance; and

means for directing the droplets of liquid substance toward the surface
of the patient's skin or other target tissue at a velocity sufficiently high to inject
the droplets of liquid substance in the patient's skin or other target tissue.

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12. A device for needleless injection of a liquid substance in the skin or
other target tissue of a patient, comprising:

a generator of droplets supplied with the liquid substance; and

a droplet accelerator for accelerating the droplets of liquid substance
15 toward the surface of the patient's skin or other target tissue in order to inject
the accelerated droplets of liquid substance in the patient's skin or other target
tissue.

13. A device for needleless injection of a liquid substance in the skin or
20 other target tissue of a patient, comprising:

means for producing a high velocity jet of gas;

means for producing droplets of the liquid substance;

means for supplying the droplets of liquid substance in the high velocity
jet of gas whereby the droplets of liquid substance are conveyed within the
25 high velocity jet of gas; and

means for guiding the high velocity jet of gas toward the surface of the
patient's skin or other target tissue in order to inject the conveyed droplets of
liquid substance in the patient's skin or other target tissue.

14. A needleless syringe for injecting a liquid substance in the skin or
30 other target tissue of a patient, comprising:

a generator of high velocity jet of gas; and
a generator of droplets supplied with the liquid substance;

wherein:

- the generator of droplets comprises an outlet for supplying the droplets
5 of liquid substance in the high velocity jet of gas, whereby the droplets
of liquid substance are conveyed within the high velocity jet of gas; and
- the generator of high velocity jet of gas comprises a channel for guiding
the high velocity jet of gas toward the surface of the patient's skin or
other target tissue to thereby inject the conveyed droplets of liquid
10 substance in the patient's skin or other target tissue.

15. A needleless syringe as recited in claim 14, wherein the generator
of high velocity jet of gas comprises:

- a convergent-divergent having an inlet; and
- 15 a pressurized gas supply connected to the inlet of the convergent-
divergent to supply pressurized gas to the convergent-divergent and thereby
produce the high velocity jet of gas.

20 16. A needleless syringe as recited in claim 15, wherein the pressurized
gas supply comprises:

- a reservoir of pressurized gas; and
- a valve interposed between the reservoir of pressurized gas and the
inlet of the convergent-divergent to controllably supply pressurized gas from
the reservoir to the inlet of the convergent-divergent and thereby produce the
25 high velocity jet of gas.

17. A needleless syringe as recited in claim 14, wherein the generator
of high velocity jet of gas comprises:

- a convergent having an inlet; and
- 30 a pressurized gas supply connected to the inlet of the convergent to
supply pressurized gas to the convergent and thereby produce the high

velocity jet of gas.

18. A needleless syringe as recited in claim 17, wherein the pressurized gas supply comprises:

- 5 a reservoir of pressurized gas; and
 a valve interposed between the reservoir of pressurized gas and the inlet of the convergent to controllably supply pressurized gas from the reservoir to the inlet of the convergent and thereby produce the high velocity jet of gas.

10 19. A needleless syringe as recited in claim 14, wherein the high velocity jet comprises inert gas.

20. A needleless syringe as recited in claim 14, wherein the generator
15 of droplets comprises:

- a reservoir of the liquid substance to be injected;
 a perforated membrane interposed between the reservoir of liquid substance and the channel for guiding the high velocity jet of gas; and
 a pressurized gas supply connected to the reservoir of liquid substance
20 to supply pressurized gas to the reservoir and force liquid substance through the perforated membrane to thereby produce droplets of liquid substance supplied in the channel and, therefore, in the high velocity jet of gas.

21. A needleless syringe as recited in claim 20, wherein the pressurized
25 gas supply comprises:

- a reservoir of pressurized gas; and
 a valve interposed between the reservoir of pressurized gas and the reservoir of liquid substance to controllably supply pressurized gas from the reservoir of pressurized gas to the reservoir of liquid substance to thereby
30 force liquid substance through the perforated membrane and thereby produce droplets of liquid substance supplied in the channel and, therefore, in the high

velocity jet of gas.

22. A needleless syringe as recited in claim 20, wherein the perforated membrane comprises:

5 a metallic or polymeric membrane provided with at least one micro-orifice.

23. A needleless syringe as recited in claim 20, wherein the generator of high velocity jet of gas comprises:

10 a convergent-divergent comprising a throat through which the high velocity jet of gas travels;
- wherein:

the perforated membrane is interposed between the reservoir of liquid substance and the throat of the convergent-divergent.

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24. A needleless syringe as recited in claim 15, wherein the generator of high velocity jet of gas comprises:

a pressurized gas supply;

a convergent-divergent having an inlet; and

20 an intermediate chamber interposed between the pressurized gas supply and the inlet of the convergent-divergent.

25. A needleless syringe as recited in claim 24, wherein the generator of high velocity jet of gas comprises:

25 a first valve interposed between the pressurized gas supply and the intermediate chamber to control supply of pressurized gas from the pressurized gas supply to the intermediate chamber; and

a second valve interposed between the intermediate chamber and the inlet of the convergent-divergent to control supply of pressurized gas from the
30 intermediate chamber to the convergent-divergent.

26. A needleless syringe as recited in claim 14, wherein the generator of high velocity jet of gas comprises:

a pressurized gas supply;

a convergent having an inlet; and

5 an intermediate chamber interposed between the pressurized gas supply and the inlet of the convergent.

27. A needleless syringe as recited in claim 26, wherein the generator of high velocity jet of gas comprises:

10 a first valve interposed between the pressurized gas supply and the intermediate chamber to control supply of pressurized gas from the pressurized gas supply to the intermediate chamber; and

a second valve interposed between the intermediate chamber and the inlet of the convergent to control supply of pressurized gas from the
15 intermediate chamber to the convergent.

28. A needleless syringe as recited in claim 20, wherein the generator of droplets further comprises:

an intermediate chamber interposed between the pressurized gas
20 supply and the reservoir of liquid substance.

29. A needleless syringe as recited in claim 28, wherein the generator of droplets further comprises:

a first valve interposed between the pressurized gas supply and the
25 intermediate chamber to control supply of pressurized gas from the pressurized gas supply to the intermediate chamber; and

a second valve interposed between the intermediate chamber and the reservoir of liquid supply to control supply of pressurized gas from the intermediate chamber to the reservoir of liquid supply.

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30. A needleless syringe as recited in claim 29, wherein the reservoir of

liquid substance comprises:

a liquid chamber adjacent to the perforated membrane for containing the liquid substance;

a gas-tight chamber; and

5 a slidable piston interposed between the liquid chamber and the gas-tight chamber;

wherein:

- the second valve is interposed between the intermediate chamber and the gas-tight chamber to control supply of pressurized gas from the intermediate chamber to the gas-tight chamber; and
- 10 - supply of pressurized gas to the gas-tight chamber apply a pressure on the slidable piston to compress the liquid substance in the liquid chamber and force liquid substance through the perforated membrane to thereby produce droplets of liquid substance supplied in the high velocity jet of
- 15 gas.

31. A needleless syringe as recited in claim 16, 18, 21, 25, 27 or 29, wherein each valve is an electronic valve.

20 32. A needleless syringe as recited in claim 16, 18, 21, 25, 27 or 29, wherein each valve is a mechanical valve comprising elements selected from the group consisting of pistons, springs and plungers.

25 33. A method for needleless injection of a liquid substance as defined in claim 1, wherein producing droplets of the liquid substance, and directing the droplets of liquid substance toward the surface of the patient's skin or other target tissue at a velocity sufficiently high to inject the droplets of liquid substance in the patient's skin or other target tissue comprises:

forcing the liquid substance through a perforated membrane.

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34. A device for needleless injection of a liquid substance in the skin or

other target tissue of a patient as defined in claim 11, comprising:

a chamber for containing the liquid substance, said chamber being delimited in part by both a perforated membrane and a movable wall; and

5 means for applying pressure to the movable wall toward the chamber in order to force liquid substance through the membrane for both generating the droplets of liquid substance, and directing the droplets of liquid substance toward the surface of the patient's skin or other target tissue at a velocity sufficiently high to inject the droplets of liquid substance in the patient's skin or other target tissue.

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35. A device for needleless injection of a liquid substance in the skin or other target tissue of a patient as defined in claim 11, comprising:

a chamber for containing the liquid substance, said chamber being delimited in part by both a perforated membrane and a burstable membrane;

15 and

a gas source for applying pressurized gas to the burstable membrane in order to burst said membrane and, after said membrane has been burst, to convey liquid substance through the perforated membrane for both generating the droplets of liquid substance, and directing the droplets of liquid substance
20 toward the surface of the patient's skin or other target tissue at a velocity sufficiently high to inject the droplets of liquid substance in the patient's skin or other target tissue.